

CARIDEA.

- (1) ALPHEUS STRENUUS.

STOMATOPODA.

- (1) GONODACTYLUS CHIRAGRA.

VERMES.

There is one species of earthworm found in all the islands, but unfortunately no specimen reached England.

2. Contributions to the Anatomy of certain Ungulata, including *Tapirus*, *Hyrax*, and *Antilocapra*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received January 28, 1909.]

(Text-figures 10-19.)

I have during the past three or four years dissected and studied various organs in a number of Ungulate animals, to which group I have indeed paid special attention in view of the fact that for obvious reasons these mostly large animals have been comparatively little examined. Indeed, of two or three of the species of Antelopes to which I shall call attention in the following pages there is, so far as I am aware, absolutely no knowledge of the structure of certain of the soft parts. A good deal of work has been done upon this group lately by Dr. Einar Lönnberg, C.M.Z.S., and upon some of the genera with which I occupy myself in the following pages, viz., *Cephalophus*, *Madoqua*, and *Gazella*. I am able, however, to add something to the large number of facts which Dr. Lönnberg has accumulated in his various papers to which reference will be made in the proper places. The notes which I have to communicate to the Society may be arranged under the following headings, viz. :—

- (1) On the absence of a Pleural Cavity in the Indian Tapir, p. 161.
- (2) Notes upon the Brain and some other points in the Anatomy of *Hyrax*, p. 162.
- (3) On the Existence of a new Skeleto-visceral Muscle in the Pygmy Hog (*Porcula salvania*), p. 170.
- (4) Notes upon the Anatomy of the Prongbuck (*Antilocapra americana*), and on the Colic Helicine in some Artiodactyles, p. 172.
- (5) Some Notes upon the Anatomy of *Madoqua phillipsi*, p. 188.
- (6) The Brain of *Babyrussa alfurus*, p. 192.
- (7) Résumé of new facts, p. 196.

(1) *On the absence of a Pleural Cavity in the Indian Tapir.*

In dissecting, some months since, an example of the Indian Tapir (*Tapirus indicus*) which died in the Society's Gardens, I was struck by the close attachment of the lungs to the wall of the chest-cavity. This attachment was by means of fine and multitudinous strands of a glistening appearance precisely like a much subdivided mesentery, and was very complete; so much so that it would be quite fair to speak of the pleural cavity as practically non-existent in that animal. It is unnecessary to dwell upon the fact that the lungs were obviously not much moveable owing to this firm connection with the walls of the cavity containing them. Inasmuch as adhesions of a similar kind are by no means infrequent as a pathological phenomenon, it behoved me to decide very carefully whether, in the example of the Indian Tapir which exhibited the condition referred to, there was not some disease of the lungs or the pleura, or of both, which would account for this remarkable state of affairs. Although I have naturally accumulated during my long tenure of the Prosectorship of this Society some knowledge of morbid appearances and structures, I called in my then colleague, Dr. Seligmann, to my assistance, who confirmed my opinion. There can therefore be but little doubt that the condition described above in *Tapirus indicus* is the normal condition. It would appear, however, that this condition has been observed in the same animal and has been put down to the effects of disease. For Dr. Murie in his account of the anatomy of this Tapir * wrote:—"The examination of the thoracic cavity exhibited the residual effects of pleurisy, there being fluid exudation and adhesions between the parietes and the lungs." It is not so very likely that so competent an observer as Dr. Murie would be mistaken as to the presence of disease; but it must be borne in mind that a normal attachment of the lungs to the parietes would not prevent the lungs from being invaded by disease!

Again Dr. Cantor says † that his specimen of *Tapirus indicus* died from inflammation of the lungs, but he gives no detail. On the other hand, neither Poelman ‡ nor Sir Everard Home § say anything bearing upon the present matter.

The interest of this remarkable obliteration, partial at any rate, of the prediaphragmatic cœlom in *Tapirus indicus* largely depends upon the fact that the same state of affairs exists in the Elephant. Quite recently Boas || and more recently still Giard ¶ have shown, in accordance with the statements of others (Miall & Greenwood, &c., quoted by Giard), that the lungs are firmly adherent to the

* "On the Malayan Tapir, &c.," J. Anat. Phys. vi. 1872, p. 139.

† "Cat. of Mammals inhabiting the Malayan Peninsula and Islands," Journ. Asiat. Soc. Bengal, xv. 1846, p. 266.

‡ Mém. Ac. Roy. Belg. xxvii. 1853.

§ Phil. Trans. 1821, p. 272.

|| "Fehlen der Pleurahöhlen beim indischen Elefanten," Morph. Jahrb. Bd. xxxv 1906, p. 494.

¶ "L'Éléphant de Afrique a-t-il une cavité pleurale," C. R. Acad. Sci. t. cxliv. 1907, p. 306.

parietes by matted ligamentous cords in both *Elephas africanus* and *E. maximus*. M. Giard goes on to suggest that the same may be the case with *Hyrax capensis*, quoting apparently confirmatory evidence from the well known memoir of George upon that animal. I myself am unable to confirm this suggestion from my dissections of several examples of both *Hyrax capensis* and *H. dorsalis*. Still there remains the Elephant, which seems most undoubtedly to resemble the Indian Tapir in this remarkable specialisation. It is difficult to form an opinion as to whether any stress is to be laid upon the fact that both these animals are Ungulates.

(2) *Notes upon the Brain and some other points in the Anatomy of Hyrax.*

The Society acquired some months ago the temporary possession of a considerable number of examples of *Hyrax capensis*, which were all about half-grown. The measurement of one individual (and all were of about the same size) was a foot or so in length. The dissection of so large a series of specimens has enabled me to add some facts to what is already known about the structure of this primitive Ungulate. I shall deal with such organs as I have specially investigated *seriatim*, and shall in some cases be able to compare them with the corresponding organs of *H. dorsalis*, of which I have dissected two examples.

Azygos vein.—I have already described* the condition of this vein in *Hyrax* and quoted the descriptions of others. It is evident from what has been written on the subject, that the prevailing arrangement in *Hyrax* is the presence of a single azygos only, and that on the right side. In all the examples to which the present note refers, this arrangement of the azygos was found. The comparative constancy of the azygos, upon which I have already ventured to insist, is thus established for the present species.

The *Brain* of *Hyrax* has been figured by several anatomists. Thus Serres gives in his 'Anatomie Comparée du Cerveau'† two views of the brain. Later Dareste reported‡ upon three brains which were not very well preserved. Of these he wrote that they "s'éloignaient du type des Pachydermes pour se rapprocher de celui des Carnivores"—no hint, here, it will be noted, of any Rodent affinities. Some years later Gervais§ figured a cast of the brain in his well-known paper upon the mammalian brain. The most complete series of figures known to me of the brain of this 'Subungulate' are those of George in his monograph|| upon *Hyrax*. The brain is figured in many views and very thoroughly. The brain of *Hyrax* is also figured by Sir Richard Owen in his

* "The Azygos Veins in Mammals," P. Z. S. 1907, p. 193.

† 1824-1827, pl. 15, figs. 269, 273.

‡ Ann. Sci. Nat. (4) iii. 1855.

§ Journ. de Zool. 1872.

|| "Monographie du Genre Daman" Ann. Sci. Nat. (6) i. 1874, pl. xvi.

text-book*. The most recent account known to me is that of Dr. Elliot Smith in the Catalogue of the Physiological Series in the Museum of the Royal College of Surgeons†.

I have examined altogether fourteen brains of *Hyrax capensis*, which permits me to contribute something to what is known of the variations of the sulci in this Subungulate. None of these brains, I should add, was among those studied by Dr. Elliot Smith. This anatomist has studied seven brains and finds "that the features of the brain vary greatly in different specimens." In addition to the brains of *Hyrax capensis*, I have examined one brain of *H. dorsalis*. I shall now proceed to review such variations as are exhibited in the fourteen brains of *H. capensis*, commencing with the dorsal surface.

The *splénial sulcus* is figured by Elliot Smith as invisible posteriorly upon the dorsal surface; its position for the last 5 mm. or so of its length is mesial and lateral, and it is therefore not to be seen when the brain is regarded from the dorsal surface. This was also the case with four of the brains examined by myself. In the others the sulcus could be seen dorsally for its entire length. This was also very markedly the case with the one brain of *H. dorsalis*.

As a rule, the splénial sulcus is quite independent of the coronary and lateral sulci. The blood-vessel running along it, however, is formed by two branches, one behind the other, to the vessel running along the coronary sulcus. These naturally slightly indent the surface of the brain. But in two specimens only out of the entire series, and in them only on the right side, was there a distinct furrow joining the splénial to the posterior end of the coronary. This furrow represents an extension of the small notch figured by Elliot Smith‡ as lying between the coronary and lateral sulci. The occasional completion of this fissure is of course suggestive of other Ungulates§. The *coronary* fissure does not always stop short of the transverse fissure or notch in the middle of the length of the brain which has just been referred to. This was, however, the case with six brains. In the others the coronary fissure was connected by the transverse fissure with the suprasylvian.

In the single brain of *Hyrax dorsalis* there was no connection between the coronary and the suprasylvian.

The *lateral* fissure showed no variations except very slight ones of length.

The lateral view of the brain is figured by Elliot Smith in two examples, which differ very considerably. I have also found a certain number of variations in the sulci of this region of the brain, which are the following:—

In eight examples I found the *suprasylvian* fissure to be very

* 'Anatomy of Vertebrates,' vol. iii, fig. 96.

† 2nd ed. vol. ii. p. 297. Dr. Elliot Smith quotes also a memoir by Turner (J. Anat. Phys. xxv. 1891) and Krueg's well-known paper; see also Elliot Smith, Trans. Linn. Soc., Zool. (2) viii. p. 400.

‡ *Loc. cit.* p. 297, fig. 168.

§ See below, p. 173, and text-fig. 11.

slightly bowed and not nearly reaching the rhinal fissure; and the single brain of *Hyrax dorsalis* agreed with these. In the remaining brains the suprasylvian fissure was carried on to the rhinal. I found an *orbital* fissure in all of the brains, and in five or six there were more or less well-developed traces of a preorbital fissure which did or did not join the rhinal fissure and rarely joined the coronary above; in the latter event the fissure did not communicate with the rhinal.

On the temporo-occipital region of the brain, *i. e.* behind and below the suprasylvian fissure, I find the existence in varying proportionate degrees of three more or less parallel fissures which are vertical in direction—and not of two only as figured by Elliot Smith. The most anterior of these is, however, obviously represented by the lowermost section of the suprasylvian fissure figured in one of Dr. Elliot Smith's illustrations*. For I have found in some brains where the suprasylvian fissure is as strongly bowed as in the illustration referred to, that the suprasylvian fissure ends anteriorly in a Y-shaped bifurcation of which in other brains one or other limb may be entirely or partly absent. In the brain figured by Dr. Elliot Smith †, as in a brain among those examined by myself, the upper anterior limb of the bifurcation is absent; whereas in the second brain figured by Elliot Smith it is, as I also have seen, the lower part of the fork which has vanished.

These three fissures seem to me to vary from individual to individual and on both sides of the brain of the same individual very often. The principal variations in the specimens examined by myself were the following:—The most anterior of the three fissures was quite absent or represented by a small rudiment which did or did not join either the rhinal or the suprasylvian fissure, or finally it effected a complete junction between these two fissures. The middle fissure which Elliot Smith letters in his drawings as the Sylvian is sometimes longer, sometimes shorter; sometimes it starts from the rhinal fissure and is sometimes unconnected with that fissure. It is occasionally broken into two smaller fissures lying one above the other. More rarely, it is connected by a transverse fissure (*i. e.* one running horizontally) with the third of the three fissures referred to and which Elliot Smith terms postsylvian. This fissure again varies very much in length and sometimes joins the suprasylvian. Very rarely it joins the rhinal below.

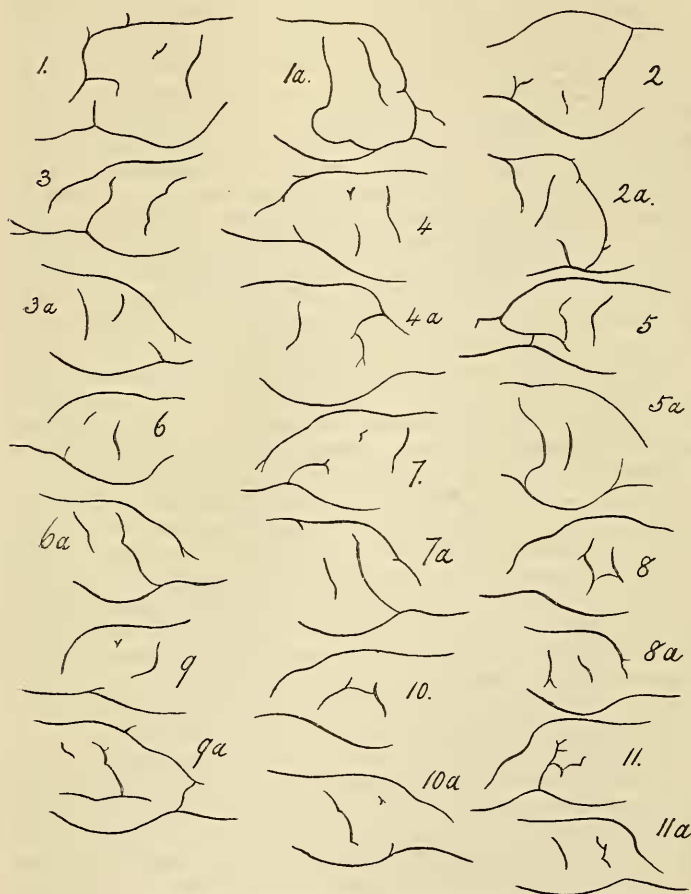
These variations are shown in the accompanying figure (text-fig. 10), where not only the differences between one brain and another are exhibited, but also those between the two sides of the same brain. I imagine that the series selected almost exhausts the variations which can occur in this region of the brain. It will have been observed in reading the foregoing remarks that nearly all the sulci of the brain of *Hyrax* are subject to variation—that indeed only the lateral furrow remains constant.

* *Loc. cit.* fig. 171, p. 299.

† *Loc. cit.* fig. 169, p. 298.

Arteries of the base of the Brain.—I figured in the 'Proceedings' of this Society some years since* the chief arteries which form or are derived from the circle of Willis in *Hyrax capensis*. A number of the brains upon which I have just reported show the

Text-fig. 10.



Lateral view of the Sylvian region of eleven brains of *Hyrax capensis*.

Figs. 1, 2, 3, &c. represent the left side. Figs. 1a, 2a, 3a, &c. the right side

Each figure is bounded by the suprasylvian fissure above and the rhinal fissure below.

cerebral arteries and enable me to amend in some particulars and to confirm in others the figure and description referred to. I have there figured no communication between the basilar artery and

* P. Z. S. 1904, vol. i. p. 187, text-fig. 18.

the right side of the circle of Willis. It is clear, however, that this specimen was so far abnormal; for in nine others (the only ones in which the arteries were visible) both divisions of the basilar artery were plainly present, thus completing the symmetry of the circle of Willis.

I find that as a general rule the basilar artery is undivided upon the medulla, as I have figured it in *Hyrax* *. But in two out of the nine specimens the artery formed a loop, such as I have figured in *Tamandua*, but longer. Such a bifurcation and re-union of the basilar artery is very common among Ungulates. In each case the vertebral artery on either side joins the anterior rhinal artery behind the loop. These arteries mark the end of the medulla oblongata. I may remark that a misinterpretation of the woodcut illustrating the arteries of the base of the brain in *Equus* in Messrs. Chauveau and Arloing's treatise, led me to compare *Hyrax* especially with *Equus* in the posteriorly situated communication of the carotid with the circle of Willis. They are as a matter of fact anteriorly placed in the Horse as in the Rhinoceros †, and posteriorly placed in *Hyrax*. In five examples of *Hyrax* I found that the carotid became continuous with the circle of Willis just opposite to the origin of the posterior cerebral artery. The other specimen examined by me did not show the relations of the artery with great clearness. I mention this matter particularly since it is not dealt with in my original figure of the arterial system of the brain. I find that the arteries at the base of the brain in *Hyrax* differ in another particular, unless indeed I have made an error in my former description. For I find that in several brains the anterior cerebellar artery arises on each side from the bifurcate basilar artery, and not from the latter posteriorly to its bifurcation. In spite, however, of these few additions to the description of the arrangement of the arteries forming the circle of Willis, it remains clear that *Hyrax* comes nearer in respect of these structural peculiarities to the Perissodactyle than to the Artiodactyle section of the Ungulates, a position upon which I ventured to insist in the paper already quoted.

Cæcum and gut of Hyrax dorsalis.—Of this species of *Hyrax* I have recently dissected two examples which permit me to compare certain organs with the corresponding organs in *Hyrax capensis* and *Hyrax syriacus*. In the general subdivisions of the cæcum of *H. dorsalis* I find no differences from those of *H. capensis*. When the cæcum is viewed on the opposite side to that on which the ileum enters it, two muscular bands as in *H. capensis* are seen to traverse the cæcum, forming by their contraction two parallel furrows upon the surface of the cæcum; these ultimately join to form a single muscular band and furrow. The junction is, however, considerably further forward in *Hyrax dorsalis*, at a point in fact corresponding to the end of the first two-thirds of the entire length of the cæcum. Furthermore, while in *H. capensis*

* *Loc. cit.* p. 189, text-fig. 19 b.

† Beddard & Treves, Trans. Zool. Soc. vol. xii. pl. xxxvii.

the cæco-colic ligament extends down to the end of the cæcum more or less along the inner of the two muscular bands only, this ligament is much less extensive in *H. dorsalis*. It lies, as in *H. capensis*, upon the outer of the two muscular bands of the cæcum, *i. e.* that on the colic side of the cæcum, but does not extend back even so far as the point where the two bands unite to form a single muscular band.

The cæcum of *H. dorsalis* then, like that of *H. capensis*, shows on the ventral side two longitudinal tæniæ where only one perhaps would have been expected. I take this to mean that the space included between these two muscular bands is the ventral surface of the median chamber of the cæcum, which is so apparent dorsally between the two lateral chambers and is externally divided from them by two muscular bands bearing blood-vessels which are continuous in front with the ileo-colic mesentery. When the cæcum is dilated with fluid, these bands are seen to produce much puckering of both the median and lateral portions of the cæcum. When the cæcum is cut open these three chambers are recognisable, but there are no permanent folds dividing them; the walls of the cæcum can be pressed flat. On the other hand, there are two anterior chambers of the cæcum, right and left, which are divided from the rest of the cæcum by permanent though low folds which cannot be stretched out flat; they are actually valve-like thickenings of the walls of the cæcum. These lie in front of the entrance of the ileum and closely embrace the dilated commencement of the colon, the bands bearing blood-vessels already referred to upon the dorsal side of the posterior region of the cæcum divide them off from the median "chamber" of the posterior region of the cæcum.

I have recapitulated these facts, firstly to show the general resemblance of *H. dorsalis* to *H. capensis* in the form and subdivisions of the cæcum, and secondly to emphasise another difference between the two species. This is the extension backwards of the median dorsal chamber beyond the two lateral chambers, so that it can be seen on the ventral aspect of the cæcum in *H. capensis*. This is not the case with *H. dorsalis*. There are thus two quite distinct differences between the cæca of these two species. The two chambers already referred to which embrace the terminal section of the cæcum or the beginning of the colon, according to the interpretation preferred, are spoken of by Lonsky* as the "mittlere Etage" of the cæcum, lying in fact between the lowest story which forms the blind end of the cæcum and the upper story out of which emerges the colon. I am inclined to consider that this region is potentially double—a meeting of the actual folds which delimit each half would convert each half into a tube—as indeed it appears to be externally. In this case a comparison may be fairly made with the two cæcal appendages of the Manatee†. Lonsky has indeed compared the cæcum of

* Jen. Zeitschr. xxxvii. 1903, p. 580.

† Murie, Trans. Z. S. viii. pl. 23, fig. 28; & Beddard, P. Z. S. 1897, p. 50, fig. 3.

Manatus with that of *Hyprax*, but not in regard to the paired outgrowths. He has rather emphasised the median chamber in which they meet, and has compared this with the two chambers of the cæcum of *Hyprax* as I consider them together with the median space common to the two. Lonsky observes that the ileum enters the middle chamber of the cæcum and that it is without an ileo-cæcal valve. The latter statement is certainly not true of *H. dorsalis*, the valve was quite obvious in the two specimens which I have dissected. Furthermore it appeared to me that the ileo-cæcal orifice lay in this species of *Hyprax* in the lower and largest chamber of the cæcum. The raised fold which separates off from this latter subdivision the two diverticula (as I regard them) can be distinctly seen to join the posterior lip of the ileo-cæcal valve, *i. e.* that nearest to the colon. On the other hand, there is undoubtedly on each side a branch of this fold which passes to the other side of the ileo-cæcal orifice. The posterior fold, however, appeared to me to be the most important. The question is obviously a difficult one to be decided. Finally (as regards the alimentary tract) I may remark that the present species, *Hyprax dorsalis*, differs from *H. capensis* and agrees with *H. syriacus* as described by Lonsky, in possessing a longish cæcal appendage of the colon lying between the true cæcum and the paired colic appendages. Nearly up to the very tip of this diverticulum, which is about an inch long, is attached the cæco-colic ligament, the other attachment of which to the cæcum has been already described. Although *Hyprax capensis* does not possess this diverticulum, there is certainly a slight dilatation of the colon where the cæco-colic ligament is fixed. It does not appear to exist in *Hyprax brucei**.

The Testes of Hyprax dorsalis and H. capensis.—In all the specimens of both of these species which I have examined, the testes (which are well known to be invariably intra-abdominal) are partly enveloped by a freely hanging membrane of considerable circumference, of which I can find no description in recent memoirs dealing with this Ungulate, and which therefore is at least not well known. The most recent and most elaborate survey of the genitalia of *Hyprax* (both male and female) known to me is in the memoir of Lonsky already referred to†.

Neither in the text nor in the figures illustrating it‡ does Lonsky refer to the membrane to which I shall presently refer at greater length. This structure has been described and figured by Pallas§, whose description runs as follows:—"Testes . . . et margine libero coronati membranula, seu ala e peritonæo facta et adipe striata, quæ vasa a spermaticis accipit." It is illustrated by a figure|| which does not, however, represent quite accurately the conditions which are observable. The sperm-duct is represented

* Chapman, P. Acad. Philad. 1904, p. 476.

† Jen. Zeitschr. xxxvii. 1903, p. 612 &c.

‡ Loc. cit. pl. 29. figs. 4, 5, 7.

§ Spicilegia Zoologica, Berolini, 1767, Fasc. 2. p. 29.

|| Tab. iii. fig. 11.

as expanding into the freely floating membrane, and thus suggesting unduly the funnel of an oviduct. This almost inclines one to the belief that Pallas had confused the epididymis with the membrane in question, though the phrase quoted above seems to negative this belief. It seems, however, that later writers have not referred to this structure, for the most part at any rate. The classical memoir of Brandt* contains no account of the membranous appendage of the testes, nor is it figured. Indeed, this anatomist has only figured the female organs. Nor is it represented by George† or Chapman‡. In both *Hyrax dorsalis*, and *H. capensis* there is invariably (so far as my experience goes) a loose fold of membrane, depending freely into the body-cavity, of a reddish colour in parts at least, and with an irregular edge, which is attached to each testis. This varies in size in different individuals (at any rate, it varied in two examples of *Hyrax dorsalis*) and is restricted to a less, or expands to be attached to a greater, area of the testes. There are also differences on the two sides of the body.

One of the most recent memoirs dealing with the anatomy of the male organs of the Elephant is that by v. Mojsisovics upon the African Elephant§. He describes "Ein nahezu vollständiger Peritonealüberzug heftet sie [*i. e.* the testis] an die mediale Seite der Niere etwas unterhalb des Hilus. Cuvier vergleicht dieses Aufhängsband der Form nach mit einem Lig. uteri laterale." I do not, however, think that this is anything more than the ligament to which I have referred and which unites testis and kidney in *Hyrax*. The late Dr. Morrison Watson|| says nothing of any such free floating membrane as that which characterises *Hyrax* in the Indian Elephant. But Camper¶ speaks of "La membrane qui les envelope formoit des deux cotés plusieurs franges garnies de longues appendices en forme de petits epiploons." The figure** illustrating this appears to me to be of a structure comparable to the testicular membrane which I here describe in *Hyrax*.

These variations suggest an organ which is no longer functional; and it is in any case difficult to see what can be the actual use in the economy of this floating sheet of membrane. It seems to be quite distinct from the narrow and tightly stretched ligament which joins the testis to the anteriorly lying kidney. It is, in fact, associated with the testis, and not with the kidney. The close association, its reddish colour, and fimbriated edges suggest very much the appearance of and association with the ovary of the oviducal funnel in Marsupials. And it is possible that this structure is really the equivalent of an oviducal funnel persisting in the male. There is, however, another possibility. The

* Mem. Ac. St. Peterb. (7) xiv. 1869.

† Ann. Sci. Nat. (6) i. 1874.

‡ Arch. f. Naturg. 1879, p. 82.

§ P. Acad. Philad. 1904, p. 476.

|| J. Anat. Phys. vii. 1873, p. 60.

¶ Description anatomique d'un Elephant mâle. Paris, 1802, p. 55.

** Loc. cit. pl. v. fig. I.

membrane in question may correspond to a gubernaculum testis diffusely developed. This, however, appears to be less likely. By many zoologists the Hyrax is regarded as forming with the Elephant a group, Subungulata, lying at the base of the Ungulate series. Recently opinion appears to be veering away from this view of the affinities of the animal. Lonsky, already quoted, sees in the alimentary tract and genitalia "the most resemblance" to the Rodents; while Erich Fischer* holds that the carpus and tarsus are not derivable from a primitive Ungulate such as *Phenacodus*, but since they combine the characters of Rodents and Ungulates are perhaps more to be compared to those of the Tillodontia or primitive Toxodonts. Finally, Assheton† cannot see in the placenta any likeness to that of any Ungulate or Elephant, but compares it on account of its "cumulate" characters to that of the Insectivora, or even to that of the Primates. It is, therefore, not without interest to note that in the characters of the testis *Hyrax* shows a likeness to one of the few other Eutherian Mammals in which the testes are completely abdominal in position throughout life, viz., *Elephas*. Lonsky denies any special resemblance in form, but says nothing of the testicular membrane with which I am at present concerned.

(3) *On the Existence of a new Skeleto-visceral Muscle in the Pygmy Hog, Porcula salvania.*

Among the Mammalia the only skeleto-visceral muscles, *i. e.* muscles which pass from some part of the bony skeleton to some viscus or viscera, are confined, so far as I am aware, to the diaphragm and to muscles in the hyoid region. Nor are such muscles very common among the lower vertebrata. We have the slips of muscle which run from the ribs to the surface of the lung, and the two muscles connecting the windpipe with the skeleton, in Birds; there are certain muscles connecting the vertebral column and the œsophagus and lungs in Frogs; the ventral sheet of muscle reaching the stomach and liver in Crocodiles and the Lizards of the genus *Varanus*; muscles in the mesentery of various Saurians, and the tongue-muscles in all of these animals. These are at least the principal instances of such skeleto-visceral muscles among Reptilia, Amphibia, Crocodilia, and Aves.

It is, therefore, interesting and not without importance to be able to add to this series a quite new muscle of the same kind in the Pygmy Hog, *Sus*, or *Porcula, salvania*. The anatomy of this pig was carefully described by Dr. J. G. Garson some years since in the 'Proceedings' of this Society‡. I cannot find in that account, which is quite comprehensive as regards the viscera, any mention

* Jen. Zeitschr. Bd. xxxvii. 1903, p. 691.

† Phil. Trans. B, vol. 198, 1906.

‡ P. Z. S. 1883, p. 413. This, moreover, is described as the "first part." The second part, dealing with muscles, has not I believe appeared.

of a peculiar muscle arising from the vertebral column in the middle line and running to be inserted on to the œsophagus.

The direction of the muscle is almost transverse, and it arises from the centre of either or both of the seventh and eighth dorsal vertebrae. It lies opposite to the second branch of the azygos vein, which in this animal is developed only upon the left side. A nearer examination of this muscle where it ends upon the œsophagus shows that it is continuous with a distinct and easily separable muscular sheath of the œsophagus. The muscle is so large that it could hardly escape being seen if the thorax of the species were examined by anyone. I imagine, therefore, that the reason why it is not described by Dr. Garson is that he intended to describe it later in the second part of his memoir dealing with the bones, the muscles, and nerves of *Porcula salvania*. After finding this peculiar and very obvious muscle in the Pygmy Hog, I looked for it in some other Suidæ, but so far with negative results. I did *not* find the vertebro-œsophageal muscle in *Dicotyles tajacu*, or in *Phacochoerus æthiopicus*. It was also apparently absent in a young *Sus cristatus*, which completes the list of Suidæ which I have examined up to the present date for this particular structure. Nor has a superficial examination of other mammals shown anything of the kind to be present. I am at least convinced that no such large muscle in the same situation or hard by exists in a large number of mammals. Unfortunately I neglected to note the minute structure of this muscle. I presume, however, from its large size that it consists of striated fibres. I have described in the heading to this section of the present communication to the Society the muscle just described as "new." I believe it to be so. But at the same time something of the kind has long been known to exist at any rate in man.

Thus Prof. Birmingham writes* :—"The longitudinal fibres [*i. e.* of the œsophagus] are often joined by slips of unstriped muscle, or elastic fibres, which spring from various sources, including the left pleura (constant, Cunningham), the bronchi, back of trachea, pericardium, aorta, &c. These slips assist in fixing the œsophagus to the surrounding structures in its passage through the thorax, and have been aptly compared to the tendrils of a climbing plant." It is plain that these slips of muscular tissue also correspond to similar slips often very numerous and closely adjacent which occur in the corresponding and in other situations in the mesenteries of Saurians. A massing of these would produce a muscle like that which I have just described in *Porcula*† *salvania*. This subject, however, evidently requires further study. All that I can say at present is that there are certainly some mammals in which a large vertebro-œsophageal muscle like that of *Porcula salvania* does not exist.

* Textbook of Anatomy; edited by D. J. Cunningham. London & Edinburgh, 1902, p. 991.

† It is true that Dr. Garson saw no reason in view of the structure of the animal for retaining the generic name. I have, however, described a new character which may go towards justifying its retention.

The sheath of muscles derived from this vertebral slip in *Porcula salvania* continues on to, or to the neighbourhood of, the diaphragm. As already mentioned, I neglected to ascertain whether this sheath and the muscular slip from which it is derived were composed of striated fibres. Supposing that they are—the most likely supposition, as I think—it may be of interest to compare this sheath with that of other mammals. In a considerable series of papers the late Mr. Gulliver* recorded a striate sheath to the œsophagus which in man may be regarded merely as a slight extension backwards of the striated fibres of the pharynx, but which is a more important matter in, for example, Rodents and Ungulates. In them the striated layer continues back to the hinder end of the œsophagus. It is possible that this state of affairs is traceable to the attachment of a muscle like that described in *Porcula*, the greater part of which has disappeared in other types, leaving only the œsophageal portion.

(4) *Notes upon the Anatomy of the Prongbuck (Antilocapra americana), and on the Colic Helicine in some Artiodactyles.*

In the most recent paper known to me upon the American Prongbuck Antelope†, Mr. Lyon enumerates the very abundant sources of information respecting the horns of that anomalous Antelope, and in discussing the systematic position of *Antilocapra* refers to Dr. Murie's account of its anatomy in the 'Proceedings' of this Society‡. I believe that this latter paper contains all that is known up to the present time respecting the visceral structures of the animal with which I am concerned in the present communication to the Society. There is thus much less consensus of opinion upon the general anatomy of this Bovine than upon the nature of the horns, concerning which Mr. Lyon refers to no less than 19 separate memoirs or references in larger works. I endeavour in the following pages to supplement Dr. Murie's paper by some notes upon certain organs which he has not described or not fully described.

The *Azygos veins* of *Antilocapra* are on the plan of those of the typical Artiodactyla, meaning in this case, by "typical," the majority. On the left side is the principal vein. This is formed of an azygos which meets a precardinal vein running from before backwards to meet the azygos or postcardinal. The former is not long. The latter is as usual rather long and extends a moderately long way back towards the diaphragm. The point of junction of the two veins and of their connection with the heart is opposite to the fifth rib (there are altogether thirteen pairs of ribs). As is the case with other Artiodactyles, as a rule there are also veins on the right side belonging to the azygos series, and of these there are two which open, the one behind the other, into the precaval

* P. Z. S. 1869, p. 249, and P. Z. S. 1870, p. 283, with other papers quoted.

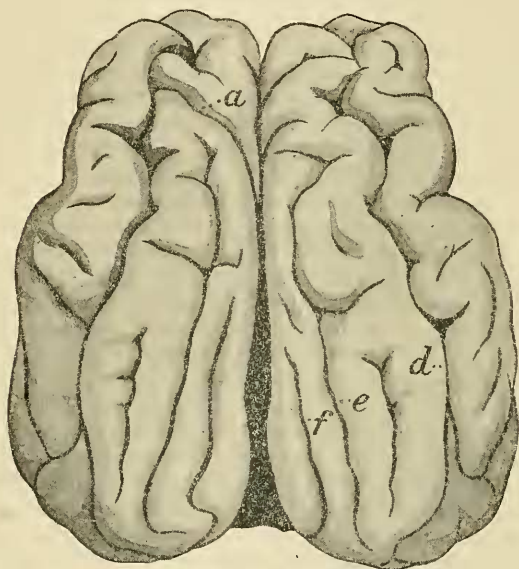
† "Remarks on the Horns and on the Systematic Position of the American Antelope," P. U. S. Nat. Mus. xxxiv. 1908, p. 393.

‡ P. Z. S. 1870, p. 334.

vein. The first of these, which is the superior vertebral vein, supplies the first intercostal space; the next vessel is formed by the union of two twigs which supply the next two intercostal spaces. It will be seen that in detail the azygos system of this Antelope differs from that of other forms. But it is at present perhaps premature to compare the genus in this respect with other Cavicorn or Cervine ruminants.

The Brain.—I believe that the brain of *Antilocapra* has not been described, though a “cast of the cranium” is referred to in

Text-fig. 11.



Brain of adult Prongbuck (*Antilocapra americana*), dorsal view. Nat. size.

a. Coronal sulcus. d. Suprasylvian. e. Lateral sulcus. f. Entolateral sulcus.

the Catalogue of the Museum of the Royal College of Surgeons*. I describe in the present communication a brain of an adult *Antilocapra americana* recently living in the Society's Gardens. The outline of this brain as seen from the dorsal side is remarkable for the squareness of the anterior portion in front of the fissure of Sylvius, as seen in the accompanying figure (text-fig. 11) and as referred to under the description of the brain of *Madoqua* on p. 190.

The *splénial* sulcus is not apparent upon the dorsal surface of the brain; its relations with the crucial sulcus anteriorly seem to me to be remarkable and unlike those of some other Artiodactyles.

* P. 335.

For example, in the brain of *Madoqua phillipsi*, which will be shortly described in the present communication, the splenial sulcus is continuous anteriorly with the crucial sulcus and does not communicate with the coronal sulcus, which sends a branch posteriorly to the middle line. Precisely the same arrangement occurs in the Sheep, as figured by Elliot Smith. On the other hand, in the Pig tribe, as is well known, and as will be also pointed out in the present communication to the Society, the splenial fissure is continued into the coronal. In the Babyrussa there would seem to be a continuation of the splenial into both these fissures. The crucial fissure and the fissure lying behind it, which represents the inner and posterior limb of the sulcus coronalis, are as plainly shown in *Antilocapra* as in *Madoqua* (cf. text-figs. 11 & 16) and in other genera*. The crucial fissure on one side (the right) joins the coronal, and on the other though continuous with the coronal it does not reach the middle line of the brain. The coronal behind is also asymmetrical, but in a different way; on the right the fissure is separated by a bridging convolution from the junction of the coronal and the branch of the suprasylvian. On the left there is complete continuity.

It is this coronal fissure which is continuous with the splenial, and not the crucial as in *Oris*. The lateral fissure proper, which I take to be the middle one of three lateral fissures, is remarkable for the fact that at the end of its first third (about) there is a strong branch at right angles on the outside, and also some indications of a similar branch at the same spot on the inside, the two together forming a cross branch. The ecto- and entolateral sulci run forwards to nearly as far as this point. The entolateral fissure, it may be observed, does not nearly reach the middle line. The suprasylvian fissure is absolutely continuous with the coronal, as in *Cervus*†. It bifurcates posteriorly in the occipital region into a Y. There are two marked descending furrows, one in front of and one behind the Sylvian. The genual fissure is not continuous with the splenial (intercalary).

In addition to the brain of the adult Prongbuck just described, I have had the opportunity of studying two foetal brains extracted from the mother, but of nearly if not quite full-time. Unfortunately they were both rather damaged at the time, but I have been able satisfactorily to compare certain of the sulci with those of the large brain. The strong branch of the lateral sulcus running at right angles to it, which seems to me to be so characteristic of *Antilocapra*, is quite obvious in both of these brains and on both sides of the brains. I have mentioned particularly the fact that the entolateral sulcus does not reach the middle line of the brain. In one of the foetal brains the relationship was the same; in the other, however, the entolateral sulcus of the left side only did dip over the mesial edge of its hemisphere. As to the continuity of the coronal with the splenial sulcus I can only

* E. g. *Cervus*, Elliot Smith, *loc. cit.* p. 329, fig. 191.

† Holl, Arch. f. Anat. Phys. pl. xviii. fig. 10, & Elliot Smith, *loc. cit.* fig. 191, p. 329.

speak of one of the foetal brains, and in that there certainly was this continuity. Furthermore, on one side of the same brain (the right—I cannot say anything of the left) the crucial sulcus was continuous with the coronal.

Muscular Anatomy.—I have dissected some of the muscles of one of the foetal specimens of *Antilocapra*, and have compared my dissections with the comprehensive account of Ungulate myology of Messrs. Windle & Parsons *. The *latissimus dorsi* cannot be said to be a feeble muscle in this Ungulate. Its origins are, as usual, in common with the trapezius and behind and contiguous to that muscle from the spines of some dorsal vertebræ, from the lumbar fascia covering over the longissimus dorsi and ilio-lumbaris muscles, and from three ribs nearer to their ventral than to their dorsal ends—from the sides of the thorax in fact. A little way down the scapula the muscle diverges from the trapezius and passes under the broad triangular scapular head of the triceps to reach the humerus. Just at this region it gives off a feebly developed *dorso-epitrochlear* branch to the elbow, and is connected with the *teres major*, in common with which it is inserted. Here also the *panniculus carnosus* is attached to the *latissimus*.

The *rhomboidei* are, as is usual in Mammals, two in number and composed of a more superficial and a deeper-lying muscle. The superficial is the more anterior of the two, but only covers the deeper-lying part of the muscle anteriorly. Its fibres are also more antero-posterior in direction than those of the other. The insertion to the edge of the cartilaginous supra-scapula commences in contact with and posteriorly to the *supraspinatus* anteriorly, and posteriorly ends a quarter of an inch or so in front of the posterior commencement of the insertion of the *serratus*. These two muscles, therefore, form a nearly complete semicircle (or rather, semiellipse) of insertion on to the supra-scapula.

The *serratus*, as already mentioned, is quite contiguous anteriorly with the superficial rhomboid and arises from eight ribs, the *latissimus dorsi* immediately following from the three ribs which lie behind those eight. Its insertion on to the scapula is both in front of and behind that of the *rhomboidei*.

The clavicular portion of the *deltoid* forms part of the great Ungulate cephalo-humeral muscle. The spinous portion arises, as in other Ungulates, not only from the spine of the scapula, but also from the fascia covering the *infraspinatus*.

The *subscapularis* is fairly extensive. It arises from and covers the greater part of the ventral surface of the scapula. There is a very small gap left between it and the semicircular insertion of the *serratus* and *rhomboidei*. Anteriorly, however, a portion of the *subscapularis* is somewhat distinct from the rest of the muscle and leaves a tract of bone, not long, between its origin and the insertion of the *rhomboideus*.

The *supraspinatus* extends over on to the ventral surface of

* P. Z. S. 1901, vol. ii. p. 626, and P. Z. S. 1903, vol. ii. p. 261.

the scapula, where it comes into contact with the anterior edge of the subscapularis muscle. It arches over the tendon of origin of the biceps and is muscular at its insertion, with however a glistening tendinous surface.

The *infraspinatus* is distinctly divided at and for some little way in front of its (therefore) double insertion into two layers, of which one overlies the other.

Teres minor is a slender muscle ending in a long flat tendon below the insertion of the spinous part of the deltoid, and therefore considerably below the insertions of the infraspinatus, which are above that of the section of the deltoid referred to.

The *teres major* is a very much larger muscle, flat and strap-shaped, and closely connected with the latissimus dorsi near to insertion.

Biceps.—This muscle is single-headed, as in other Ungulates. The strong tendon of origin seems to me to arise very distinctly from the coracoid process, but also doubtless from the adjacent margin of the glenoid cavity. Low down on the arm and at the end of the insertion of the pectoralis, a stout fibrous band is given off which runs diagonally towards the elbow. This is chiefly connected with the lower end of the pectoralis, but is adherent to the biceps where it crosses it. A little further down and just before its insertion the biceps is connected with a stout tendinous sheet running down the forearm, in the centre of which is a stouter tendon which can be seen to end on the surface of the biceps.

The *brachialis anticus* winds round the humerus in the way that has been described in other Ungulates. Its insertion is remarkable for the fact that it is adherent by a tendon to the stout tendinous plate running down the forearm, which has just been described, in connection with the biceps before its definite insertion on to the ulna.

Triceps.—This muscle consists of at least four very distinct parts, unless it were better to term one of these anconæus. Of these heads the scapular was precisely as described by Windle & Parsons, arising from a large portion of the axillary border of the scapula. When cut across transversely, there were considerable indications of the division of this muscle into two layers, as also noted by those authors. The inner humeral head seems to be peculiar in some respects. It arises below the coracobrachialis and immediately divides into two muscles, of which the posterior is more or less cylindrical in form in the middle and circular in transverse section, and is totally free from any connection with the shaft of the humerus. The larger portion, that lying anterior, has an origin from the humerus for about halfway down the shaft of that bone. When it becomes free it is rejoined by the other slip of the muscle just before mentioned, and the two form a flat tendon at the internal condyle. The external head arises on the opposite side of the humerus and is a broader and strap-shaped muscle. It closely covers the brachialis anticus at its

origin. In addition to these three heads there is a fourth, which is obviously referable to the triceps complex. Its origin is from the lower half of the humerus and its situation is posterior to and between that of the last two heads mentioned. It is divisible into two parallel muscles, which join before their fleshy insertion on to the olecranon to the external side of the rest of the triceps.

Antilocapra has only three extensor muscles the tendons of which are inserted upon the phalanges of the toes, or rather four, of which two become united at the wrist, and may therefore be regarded as a single muscle. In the middle of the metacarpus only three tendons can be seen. Messrs. Windle & Parsons describe as long extensor muscles in the Ungulata the tendons of which are inserted upon the phalanges: (1) Extensor communis digitorum; (2) Extensor minimi digiti; (3) Extensor profundus digitorum, which, however, is described as only occurring in the Elephant and occasionally in Suidæ.

The four muscles in *Antilocapra* have the following origins and insertions:—

(1), (2). Two muscles arise one below (not deep of) the other, and in close contiguity at their origin from the external condyle; the lower head, which is the smaller, also varies, and perhaps may be said to chiefly arise from the shaft of the ulna quite at the commencement of the latter. The two tendons are perfectly distinct until a little way beyond the wrist, when they absolutely join. These two muscles together form, as I presume, the *extensor minimi digiti* (or *extensor digitorum lateralis*).

(3). A thin muscle, arising from the external condyle under cover of the upper part of the extensor minimi digiti, is reinforced by a long slender muscular slip from the ulna, and ends in a tendon which closely accompanies that of the next muscle to be described. The tendon runs between the two toes covered by the intrinsic extensors of the hand and supplies both digits. This tendon with its two branches contrasts with the broad flattened termination of the tendon of the extensor minimi and of the next muscle to be described. The division of the tendon into two is quite low down, in fact at the very end of the cannon-bone. I imagine that this muscle is the *extensor communis digitorum*.

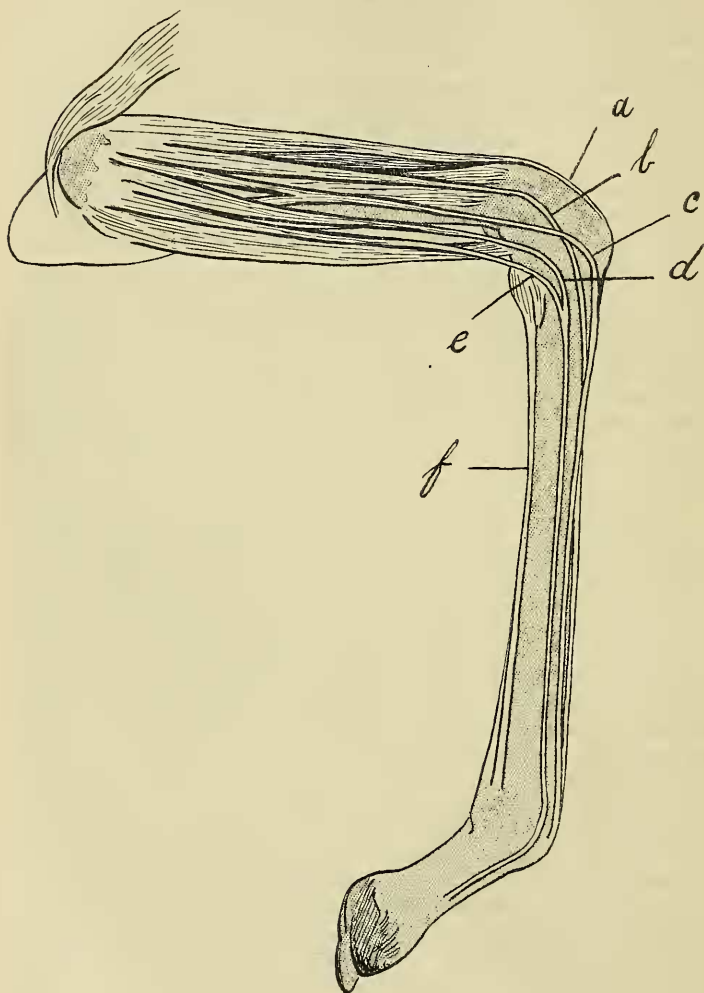
(4). The third (see above), or perhaps fourth, long extensor muscle of the hand of *Antilocapra* arises higher up the humerus, below and in contact with the thick fleshy extensor carpi radialis. Its tendon, which has been already referred to, supplies the medius digit. It has no second head that I could discover. I suppose that this muscle is the equivalent of the *extensor profundus digitorum*, which has been stated in the case of the Pig to be inserted upon the index and medius digits*.

I now pass on to the muscles visible on the extensor side of the forearm before considering the arrangement of the flexors.

* *vide* Windle & Parsons.

The *extensores carpi radiales longior et brevior* form, as in Ungulates generally, a single muscle, unless indeed the muscle which has just been referred to as the extensor profundus is really the longior. It has the broad strap-shaped tendon described in other forms. A muscle, which I presume to be the *pronator radii teres*,

Text-fig. 12.



Antilocapra americana. Musculature of outside of forearm.

- a.* Extensor carpi radialis. *b.* Extensor profundus digitorum. *c.* Extensor communis digitorum. *d* & *e.* Two tendons just before their junction of the double extensor minimi digiti. *f.* Flexor sublimis.

arises from the ulna and extends over the radius for a long distance towards the wrist.

Finally, on the extensor side of the forearm is to be noted the *extensor carpi ulnaris*.

On the flexor side of the forearm the following muscles are to be seen :—

The first of these, beginning at the lower border, is the *flexor carpi ulnaris*, which is exactly opposite to the extensor carpi ulnaris, and arises from the olecranon as well as from the internal head of the humerus. Its insertion is parallel and contiguous to that of the extensor carpi radialis.

The *flexor sublimis digitorum* arises from the internal head of the humerus and from the surface of and in common with one of the heads of the flexor profundus. It has only one fleshy belly, which ends in a single tendon.

The *flexor profundus digitorum* is also, like the last muscle, rather different from the corresponding muscle in other Bovidae. It has four heads. The first of them is the most superficial, and arises from the internal condyle of the humerus in common with the last muscle, beneath the flexor carpi ulnaris. Two heads of unequal importance arise deep of the last and also from the internal condyle. The fourth head is entirely ulnar in origin, in fact from the olecranon. Its tendon joins that of the two last described heads at about where they join each other. There is not any muscular palmaris longus that I could find, but a very strong tendon flattened in form and much stronger than any of the other tendons of the hand.

The *flexor carpi radialis* presents no peculiarities.

I could find no lumbricales.

There were two short extensors between and below which runs the tendon of the extensor digitorum.

Some of the muscles of the fore limb are illustrated in the accompanying figure (text-fig. 12), and include those in which *Antilocapra* certainly differs from other Ungulates according to the elaborate account given by Messrs. Parsons & Windle of the myology of that group.

In the hind limb, the sheet of muscle and fascia which corresponds to the *gluteus maximus*, *femoro-coccygeus*, *biceps*, and *tensor fasciæ femoris* is attached, as in other Ungulates, to the fascia covering the knee and foreleg for about halfway down. Of this mass I have not been able to recognise all the elements mentioned above as distinct muscular sheets. The tensor fasciæ arising from the ilium in front, is the most conspicuously separate. The others seem to me to form a continuous sheet of muscle, arising from the tuber ischii and the caudal and sacral vertebræ in front. Three *glutei*, besides the maximus, are easy to dissect and separate, and are all attached to the greater tuberosity of the femur, the *glutæus medius* to its free edge, and the other two in front and near to its origin from the femur.

I have no particular remarks to offer with regard to the very

wide *gracilis*, the narrow *sartorius*, and the *semitendinosus* and *semimembranosus*, except that the *semitendinosus* has only one head from the tuber ischii. I am unable to identify with certainty a *preseminembranosus*. The muscle which I term here *semimembranosus* is one muscle arising from the tuber ischii and covering over the adductor which lies deep of it. It is double nowhere along its course, and is inserted along a semicircular line from the end of the femur to the beginning of the tibia, covering over the origin of the *gastrocnemius*. There is no separation at the insertion into two muscles, nor is there any rounded tendon, the insertion being mainly muscular. There is, however, some connection just at the insertion into the extremity of the adductor and also with the head of the *gastrocnemius*. In any case there is nothing like the separation of two fleshy bellies such as are figured by Messrs. Windle & Parsons*.

With regard to the *quadriceps femoris*, I have only to observe that the *vastus internus* is much smaller than the *vastus externus*. The *pyriformis* was perfectly distinct from the *entoglutæus*.

The *tibialis anticus* has but one head of origin, and that is a long flat tendon arising from the external condyle of the femur and passing over the knee in front to form a fleshy belly which ends in a long tendon fanning out at its insertion. A muscle corresponding to the second (tibial) head also exists which ends in a tendon which perforates the tendon of the last and is attached considerably below it, *i. e.*, nearer to the ventral side of the foot.

The *extensor longus digitorum* seems to me to arise only from the fascia between the muscle itself and the femoral head of the *tibialis*. Besides the tendon of this muscle another tendon runs along the anterior face of the metatarsus. The two tendons of the *extensor longus* are separate before the ankle, although they run along the metatarsus closely bound together. The third tendon I refer to the *peroneus quarti digiti*. The *peroneus longus* is also present. No other *peroneals* were found.

I have also dissected the *gastrocnemius* and *soleus*, and find them to be as in the Bovide. That is to say, that the small and fleshy *soleus* arises from the head of the fibula and joins the outer head of the *gastrocnemius*.

The *plantaris* is remarkable for a relationship to the *gastrocnemius* not commented upon by Messrs. Parsons and Windle. In one specimen that I dissected, there is an intimate connection between the *plantaris* and the outer head of the *gastrocnemius* shortly after their origin. Some of the fibres of the *gastrocnemius* arise from the fascia separating it from the *plantaris*. In fact, the two muscles cannot here be separated by dissection. In the other specimen there was also a connection between the two muscles but rather different in its kind. A slender tendon

* *Loc. cit.* fig. 26, p. 274, S.M. and P.S.M.

left the plantaris and swelling into a slender muscular belly joined the gastrocnemius.

The three *flexors*, viz., *fl. tibialis*, *fl. fibularis*, and *fl. tibialis posticus*, are present, and their tendons were as usual. It is important to note the presence of the last-named muscle, which has been said to be absent in Bovines.

Intestinal Tract.—Dr. Murie* says very little about the intestinal tract of the animal, merely giving the lengths of the several regions and noting the absence of an ilio-cæcal gland. I find the colic spiral to be quite typically ruminant in its characters, and to be perhaps rather large for so small an animal. In one of the two fetuses in which I studied it carefully, the colic spiral was not flat, as it is in some Antelopes with but few coils, but convex. A transverse section through the centre of the coil and including the tract of colon immediately after it has left the cæcum, would cut through the colon fourteen times. The spiral is thus very much longer than—for instance—that of *Madoqua* to be later described. Furthermore, it is to be noted that there is in the foetus which I examined no marked ansa paracæcalis; the colon where it emerges from the cæcum is not at all bent upon itself in the way so characteristic of many Artiodactyles and Rodents. I could detect no definite ansa paracæcalis; and in this *Antilocapra* agrees with *Tragulid* (see text-fig. 14, p. 184), where there is no loop between the cæcum and the spiral loop.

The cæcum itself has no peculiarities; it has the usual sausage shape and blunt tip of that of other Ruminants. There is some variation among the Ruminants in the degree to which the ileo-cæcal mesentery extends along the cæcum; in *Antilocapra* the membrane extends about halfway along the cæcum. The colon, when the spiral is left, runs at first in a wide loop which is thrown distally into a number of loose folds which are like those of the small intestine in not being permanent. After this a short tract of the colon is attached by membrane to the cæcum; thereafter a short and wide but fixed semicircular loop of colon ends in a short straight rectum. I have examined and can compare with *Antilocapra* as regards some of the facts just mentioned, three species of *Cephalophus*, viz., *C. maxwelli*, *C. melanorrhous*, and *C. dorsalis*. In all of these there is a well-marked ansa paracæcalis. In none of them is there so complex a colic spiral as in *Antilocapra*. Lönnberg has examined several species of *Cephalophus*†, but has not seen *C. dorsalis* which presents differences from *C. maxwelli*. *C. dorsalis* is a larger species than the latter but is differently coloured; it also possesses inguinal glands, which are wanting in both of the other species I have referred to above. While in *C. melanorrhous* and *C. maxwelli* the colic spiral forms a complete circle and about half a circle, it forms two complete circles and a little more in *C. dorsalis*. In a

* P. Z. S. 1870, p. 350.

† Nova Acta Reg. Soc. Upsala, 1903.

transverse section across the coil in the two former species the colon would be cut across eight times; in the case of *Cephalophus dorsalis* ten times. The result is of course that the apex of the spiral is rather different in the two cases. Furthermore, while in *C. melanorrhous* and *C. maxwelli* the ileo-cæcal mesentery is inserted up to the very tip of the cæcum, it falls considerably short of this in *C. dorsalis*.

Dr. Lönnberg* has used a very convenient method of expressing the direction of the various loops of the colic spiral, which I adopt in comparing *Antilocapra* with *Cephalophus* and some other forms (see text-fig. 13). The thick black line indicates the entering colon; the pale line the colon which leaves the coil. The letter X indicates a fixed point in all the figures, *i. e.*, the extremity of the colic spiral, which is of course merely a single loop like that of *Lemur*, &c., and is wrapped within its own curves to form a spiral. It will be noticed that the simplest spiral exhibited among these Antelopes is that of *Madoqua* which will be described later. It forms a complete circle, each limb being approximately equal. The spiral of *Cephalophus dorsalis* is a further advance upon this; the spiral in this Antelope consists of two circles, each limb again being approximately equal. It will be noticed that in both these cases the limb of the spiral, which is continuous with the cæcal side of the colon, ends on the same side of the spine as that on which the cæcum lies, and, furthermore, that the number of the loops of the entering and outgoing colon are equal, *i. e.*, three of each in *Madoqua* and five of each in *Cephalophus dorsalis*.

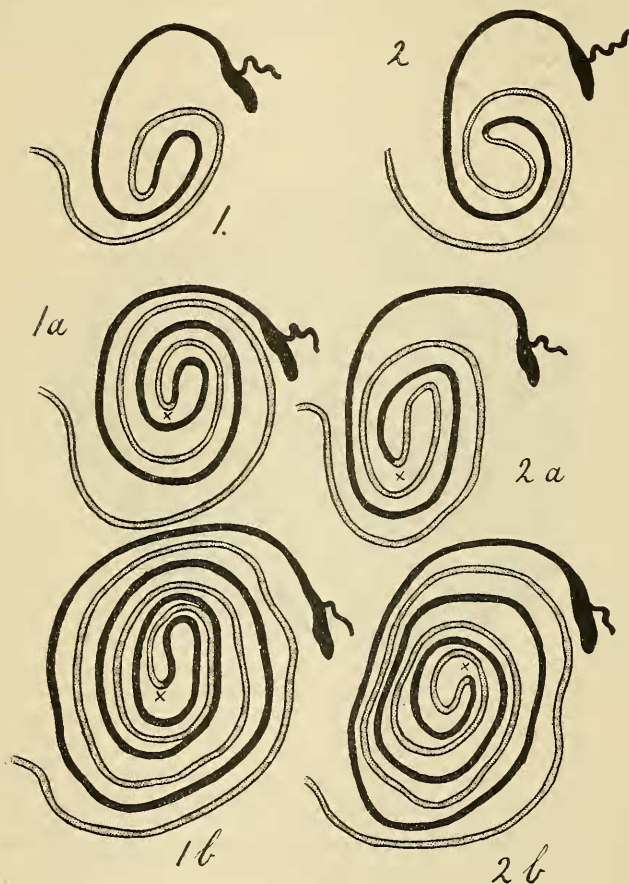
Tragulus stanleyanus, *Cephalophus maxwelli*, and *Antilocapra* form another and a parallel series of ascending complexity. The first-named is on the same level as *Madoqua*. The spiral has only one turn. But the arrangement of the loops is different.

It happens that in *Tragulus stanleyanus* the end of the spiral is directed away from the cæcal side of the spiral, *i. e.*, transversely to the antero-posterior axis of the spiral and to the direction of the terminal loop in the other types already described. It will be seen, however, that if the spiral be increased by half a turn so that the axis of the end of the spiral be made to coincide with that of the other types, the limb of the terminal part of the spiral which lies on the cæcal side of the spiral is not a part of the entering coil of intestine as in *Madoqua* and *Cephalophus dorsalis*, but of the outgoing coil. In *Cephalophus maxwelli* the spiral is more complex, *i. e.* larger, but there is precisely the same relative position of the entering and outgoing limb of the spiral as in *Tragulus*. So finally in *Antilocapra*, which belongs to this same series. Here, however, the tip of the spiral is directed upwards; but if this be altered so as to make the spiral of the same length as in *Cephalophus maxwelli*, it will be seen that the limb of the spiral which forms the cæcal side of the

* Zoologiska Studier tillägnade Prof. T. Tullberg. Uppsala, 1907, p. 248.

terminal portion is the outgoing spiral, precisely as in *Cephalophus maxwelli*. It is not at all surprising—if the facts be properly considered—to find that *Cephalophus dorsalis* and *C. maxwelli* are not near akin in the nature of their colic spirals. The

Text-fig. 13.



The colic helicine in various Artiodactyles, arranged in two series, *i. e.* 1, 1a, 1b, and 2, 2a, 2b. The cæcum is represented to the right and the ingoing limb of the spiral is black. The outgoing limb of the spiral is left uncoloured.

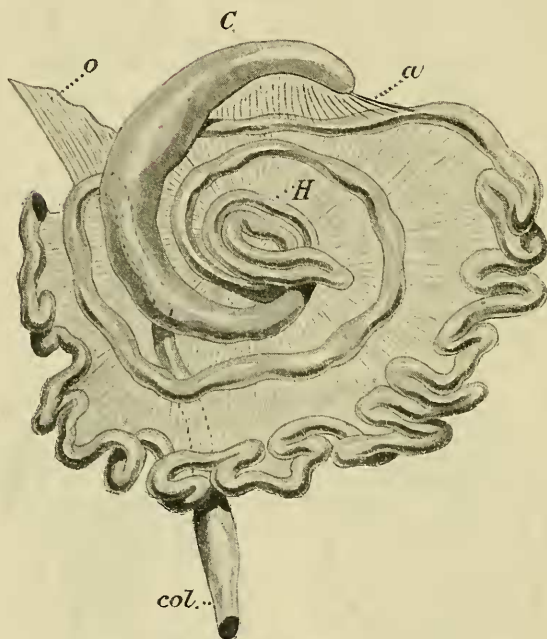
1. *Madoqua phillipsi*. 1a. *Cephalophus dorsalis*. 1b. *Moschus moschiferus*.
2. *Tragulus stanleyanus*. 2a. *Cephalophus maxwelli*. 2b. *Antilocapra americana*.

differences in external characters appear to me to be quite as great as those which distinguish certain other genera of Antelope,

and even greater than those which have been used in a few cases. The internal difference only confirms the value of these characters.

The spirals described in the foregoing paragraphs are committed—so to speak—to one of the two series of right-handed spirals. There is no common basal form from which might arise either type of spiral. Whether such exists among the Artiodactyla remains to be seen. It is important to notice that this does not occur in the case of the simplest spiral known in that

Text-fig. 14.



Caecum, colic helicine, and adjacent parts of the gut of *Tragulus stanleyanus*.

a. Front edge of caeco-duodenal ligament. *C.* Caecum. *col.* End of colon or beginning of rectum. *H.* Colic helicine. *O.* Omentum.

subdivision of the Ungulata, viz., that of the Chevrotains. It does not thus seem likely that such a spiral will be found in any genus which has not been up to the present examined. There is no doubt, for instance, that the Pig tribe does not help us in this matter in the least. For in most of them at any rate, and probably in all, the colic spiral is very complex and specialised, and offers no hints of the primitive condition. This applies to the Peccary as well as to the more specialised pigs. Nor do the

remaining subdivisions of the Ungulates help us in this search. In neither *Hyrax* nor *Elephas* are there any beginnings of the spiral. It is true that the simple colic loop of the Perissodactyles (found in all the families of Perissodactyla) may be regarded as the progenitor of the spiral; but this is going too far back in the evolution of the spiral. What is wanted is a simple spiral of a negative character which with further growth might evolve into either type. Now it is interesting to find that this form of spiral—precisely what is wanted to serve as a starting point—is to be seen in those Lemurs with a simple colic spiral, i. e., *Galago**, *Loris*, *Perodicticus*, and *Nycticebus*. It will be seen from an inspection of the figure that this simple spiral can be easily regarded as a three quarters of a circle spiral with the apex of the spiral pointing upwards, and of course with the outer limb of the descending part of the colon turned towards the cæcum. On the other hand, it may be regarded as a commencing spiral of half a turn with the apex pointing downwards. In this case it obviously belongs to the other series, for if the spiral were continued so that the apex pointed upwards, the limb forming the apex and nearest to the cæcum would be that of the inner limb of the loop. It is perfectly clear, therefore, that a growth of this rudimentary spiral could produce either of the two types of Artiodactyle spiral with which I am concerned in the present communication. This is of course not tantamount to insisting upon any close relationship between the Ungulates or the Artiodactyle Ungulates and the Lemuroidea†. But it is at least important to note that while the only widely distributed sub-families of the Lemuroidea have preserved without variation an archaic and indifferent form of spiral, the most archaic Artiodactyles have not the simplest form of spiral conceivable. So far, therefore, it would appear as if the colic spiral as such had been inherited by the Artiodactyles. It is, of course, not at all certain that the single loop of the Perissodactyle Ungulates is the homologue of the Artiodactyle spiral; it may represent the ansa paracæcalis of the latter.

The facts detailed under the above descriptions of the anatomy of *Antilocapra* may be supplemented by some account of the intestinal tract in other Artiodactyles which I have had recently the opportunity of examining at the Prosectorium. Among those the most interesting perhaps is that of the Musk Deer (*Moschus moschiferus*)‡. The viscera of this animal, including the alimentary tract, have been described by Sir W. H. Flower§ and Prof. Garrod||. The cæcum is figured by Flower, but the colon is not specially described. A footnote adds that in

* For non-diagrammatic figure see Beddard, P. Z. S. 1908, p. 578, fig. 114.

† Moreover, the apparently similar colic spiral found in certain Rodents (*Hydrochærus*, *Dasyprocta*, and *Calognys*) requires further consideration from this point of view.

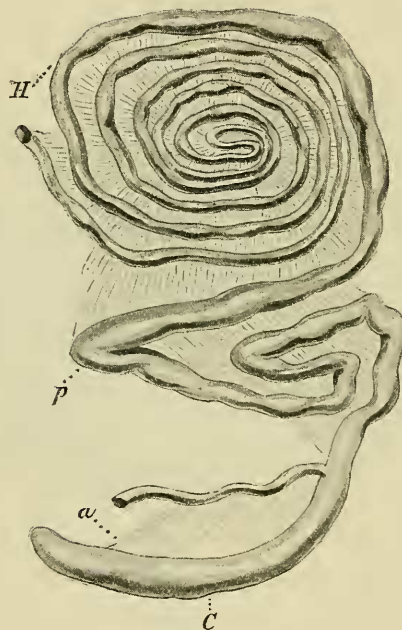
‡ A female dissected Dec. 21, 1908.

§ P. Z. S. 1875, p. 159.

|| P. Z. S. 1877, p. 287.

the Pudu Deer (*Pudua humilis*), of which a specimen was dissected at the same time by Sir W. H. Flower for the purpose of comparing with *Moschus*, a deer of about the same size, "the colon . . . forms a very simple helicine coil, composed of two complete circles in one direction and of two in the other"*. It is not clear whether it is to be inferred that *Moschus* agrees. In any case, Garrod describes the colic spiral as having three and a half double turns. This statement is approximately correct, as

Text-fig. 15.



Cæcum, colic helicine, and adjacent parts of the gut of *Moschus moschiferus*.

p. Ansa paracæcalis. Other lettering as in text-fig. 14.

will be shown by the annexed figure (text-fig. 15), which gives the same number of coils as has the spiral of *Antilocapra*. The termination of the spiral, however, points downwards, in which *Moschus* disagrees with *Antilocapra*. Nevertheless, it belongs to the same series as that which commences with *Madoqua* (see p. 183). With regard to the ileo-cæcal ligament I confirm Sir W. H. Flower that it is not attached up to the very end of the

* *Loc. cit.* p. 171.

cæcum. It is important to note that this character is apparently a constant one, which I have used above (p. 181) in distinguishing other Antelopes. The ansa paracæcalis of *Moschus* is not dealt with by either Flower or Garrod. It is remarkable in that it is bent upon itself four times to form a small spiral, which is quite as conspicuous a spiral as is that of the Lemurine subfamilies Galaginæ and Lorisinæ, and may even, quite possibly, really be the equivalent of that colic loop—the true ansa coli dextra of the Rodents being in that case absent from the Lemurs.

In *Gazella rufifrons* (a female) the ansa paracæcalis is roughly of the shape of the letter “m.” That is to say, it consists of two parallel loops. Immediately after the ansa paracæcalis the colon diminishes suddenly in calibre, and enters the region of the colic spiral or ansa coli dextra. This is a comparatively simple coil. It is only a little more complicated than that of *Madoqua* described on page 189. Cut right across, the colon would be divided seven times, counting the straight tracts which enter and which leave the coil. As usual, the small intestine is festooned along the colon after the colic spiral. The colon in this region passes almost completely round the circumference of the abdominal cavity, and forms nowhere any special loops. The duodenum where it turns upon itself is fixed, as in other Antelopes, to the colon itself, and not to the mesocolon.

With regard to the colic spiral, it is to be noted that it belongs to the type of *Cephalophus maxwelli*. But the loops do not form a regular watchspring as in those Artiodactyles already considered. For the terminal loop of the spiral does not lie entirely within the coil but extends beyond it.

Dr. Lönnberg comments upon the remarkable colic spiral of the Musk-Ox*. In addition to the spiral coil there is a separate loop formed by the outgoing limb of the spiral, as is depicted in his figure. It seems to me that this state of affairs is comparable to the presence in so many Rodents of two ansæ coli, the dextra and sinistra. The two are close together in Squirrels, for example. If one of these—and they are frequently of different sizes—were converted into a spiral, we should have a condition produced which would be precisely like the Musk-Ox. For the lengthening of the one loop—already the longer of the two—to form a spiral would bring it about that the shorter ansa, remaining a simple tubular loop, would be affixed to the back or to the front of the spiral, as is actually the case in the Musk-Ox. There is, however, no need to theorise; for the Rodent *Dasyprocta punctata* shows exactly the same conditions as those met with in the Musk-Ox. In this species† there is a short spiral and also a simple loop closely affixed to it. I take it that this is a simple form of the complex spiral and associated loop found in the Musk-Ox.

* But only in one specimen out of two; the other showed a single spiral only.

† P. Z. S. 1900, p. 152, fig. 7.

(5) *Some Notes upon the Anatomy of Madoqua phillipsi.*

A dissection of an example of this small Antelope enables me to make a contribution to the knowledge of the structure of the Cavicorn Ungulates, for I believe that we have at present no information as to the anatomy of this particular genus of Antelopes, beyond the notes contained in Lönnberg's paper already referred to.

The example which I examined was a female. The usual four teats were present and also as usual the anterior pair were much further away from each other than the pair lying behind them. There was no trace that I could see of the inguinal glands, and, indeed, the inguinal region, instead of being bare, was particularly well covered with long hair. I have notes upon some of the organs, and I naturally paid special attention to those structures which are known to vary in these animals.

As to the *Vascular System* I found that the heart shows the "moderator band" so frequently found in running animals—birds as well as mammals*. It was a considerable fleshy column connecting together the free and septal walls of the right ventricle. The postcaval vein was typical in its arrangement, *i. e.* the vein lay postrenally to the right of the aorta. The azygos had the following structure:—

The general plan is like that of other Artiodactyles. That is to say, the right azygos is much less important than the left. The latter opens moreover, as is usual, directly into the heart, but it consists of two portions, an anterior and a posterior. They unite just opposite to the transversely running vessel which is formed by their union and debouches into the heart. There is thus, as I may point out, a remnant of the left anterior cardinal, which I presume the anterior branch of the left azygos to represent. This fact in the structure of the azygos of *Madoqua* is furthermore of some systematic interest. For, as I have discovered† in *Rhaphicerus* and *Ourebia*, the arrangement of the veins bringing back blood from the dorsal parietes on the left is quite like that which has just been described in *Madoqua*. Now these three genera have been placed in the same subfamily Neotraginæ. This additional structural likeness justifies still further this placing. The right azygos of *Madoqua* is but feebly developed and brings back blood from only two or three intercostal spaces.

In the *intestinal tract* of Antelopes it is the colon which shows the principal differences. I have therefore made careful notes upon certain points in the structure of that part of the gut in *Madoqua phillipsi*. The *cæcum* is long and like that of other Antelopes in its blunt ending without any diminution of calibre. The *ileum* enters it at an acute angle and is attached to it by mesentery which extends a long way towards the tip of

* To which particular attention was called by the late Prof. Rolleston.

† "On the Azygos Vein in the Mammalia," P. Z. S. 1907, pp. 184, 185.

the cæcum. The *colon* as it leaves the cæcum shows hardly any trace of the paracæcal flexure so common in these animals. There is practically no twisted section of colon at this point. Furthermore, the *colic spiral* is very much reduced, a fact which one naturally associates with the small size of the animal. It is in fact, as the accompanying text-figure shows (text-fig. 13, p. 183), no more complicated than in the Lorisine Lemurs*, which show the simplest colic spiral known to me. A transverse section across this spiral would in fact only divide the colon five times.

This of course recalls the diminutive spiral of the Chevrotains described by Milne-Edwards† and more recently by Mitchell‡. It is to be noted, however, that the spiral in *Tragul* (see text-fig. 14, p. 184) is rather different from that of *Madoqua*. For in the latter the spiral is flat, and is separated from the cæcum by the ileum to which it is attached by mesentery, just as the ileum in its turn is attached to the cæcum by a band of mesentery. In *Tragul* the small spiral is fixed on to the cæcum near to its colic end. It appears to me possible that this spiral in *Tragul* is not the precise equivalent of that of other Artiodactyles, but is the ansa paracæcalis which tends to show a spiral form in many. For example, in the small Antelope *Cephalophus abyssinicus*, of which I have lately dissected an example, the ansa paracæcalis was much more conspicuous and complicated than that of *Madoqua* and tended towards a spiral arrangement; so too with *Moschus* described and figured above. It may also be that the distinctly spiral commencement of the ansa paracæcalis in *Hyrax*§ is referable to the same category, as is also that of many Rodents.

There is, however, some variation in the colic spiral of Ruminants which may be a question of age or of actual variation. I have pointed out that in the Rodent *Hydrochærus*|| the younger individuals have a rudimentary spiral which later becomes large. I have examined this spiral in two examples of the Antelope *Tragelaphus scriptus*, both females. In one specimen the coils were hardly more complex than in *Madoqua*. The colon consisted in this region of four loops each consisting of two limbs, so that a transverse section across this region of the gut would divide the colon eight times. On the other hand, the second specimen had a more complex colic spiral.

I may observe that the close connection of the small intestine with the colon—for the former gut is attached by mesentery to the colon for some distance after the colon has emerged from the colic spiral—is a feature often (?always) found among Artiodactyles; it is paralleled in a remarkable way in the Beaver, another fact illustrative of the numerous structural resemblances between the Rodents and Ungulates.

* Beddard, P. Z. S. 1908, p. 578, and literature therein cited.

† Ann. Sci. Nat. 1864.

‡ Trans. Zool. Soc. vol. xvii. p. 472, fig. 19.

§ P. Z. S. 1908, p. 532.

|| P. Z. S. 1908, p. 537.

Dr. Lönnberg has specially devoted himself to the intestinal tract (and other features in the anatomy) of the Artiodactyles*. As these animals are comparatively little known in the anatomy of their soft parts, I do not hesitate to set down some further facts as a contribution to our gradually increasing knowledge of the group, which may prove to be distinctive not of the particular species now under consideration but of the group generally. In *Madoqua*, as in *Cephalophus abyssinicus*, the end of the duodenal loop is not fixed by the ligamentum cavo-duodenale to the post-caval vein or to the mesocolon, but to the ventral surface of the colon itself.

Some of the recto-duodenal ligamentum strays over on to the adjacent right kidney. I could find no definite hepato-renal ligament. But the right extremity of the liver was attached to the parietes by a well-marked ligament. I may remark also that in *Cephalophus abyssinicus* the duodenum was attached to the rectum itself in precisely the same way by a ligament, and that there was also the same attachment to the right kidney. The left kidney was situated a long way below the right kidney, there being a considerable distance between the posterior end of the right kidney and the anterior end of the left kidney. The spleen of *Madoqua* had the more or less circular contour of this "gland" in some other Ruminants. It was as firmly fixed to the stomach throughout as in other Ruminants. There was in fact no free gastrosplenic omentum.

The *Brain* of *Madoqua phillipsi* is not known, so far as I am aware, and will serve to illustrate the brain characteristics of a small Antelope with the sulci in a simple condition. It may be compared with that of *Antilocapra*, which I also figure in the present communication. The general outline seems to me to be remarkable for the square outline and termination anteriorly of the portion of the brain lying in front of the Sylvian fissure. This form of brain is still more marked in the Pronghorn, which I have dealt with on a previous page. Secondly, as will be seen in the drawing of the dorsal surface submitted herewith (text-fig. 16), the corpora quadrigemina are partially visible, which is at least unusual among the Ungulata. The third obvious peculiarity, also to be seen in the same dorsal view, is the exposure of the splenial sulcus which runs on each side a curved course at some little distance from the median fissure of the brain. The exposure of this fissure is not unknown in other Artiodactyles—it occurs, for instance, in *Tragulus*†, *Dorcatherium*, *Moschus*, *Cervulus*—but it must not be confused with an entolateral sulcus, such as occurs in *Cervus dama*‡, and which at first sight might be confused with it. Its continuation with the crucial anteriorly

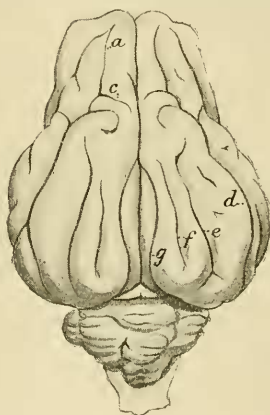
* Nova Acta Reg. Soc. Upsala, 1903; K. Vet.-Ak. Handl. 1901; P. Z. S. 1900, p. 142; and in Zoologiska Studier tillägnade Professor T. Tullberg, 1907, p. 237.

† See Cat. Physiol. Series, Roy. Coll. Surgeons, Vol. ii. 2nd ed., 1902, p. 323, p. 324, p. 325 fig. 187, p. 327.

‡ *Ibid.* p. 329, fig. 191.

shows that in *Madoqua* the fissure in question is really a splenial. Dr. Elliot Smith has remarked* that "the position of this sulcus in the Ungulata seems to be determined largely by the size of the hemispheres," it being visible above in *Tragulus* and not in *Cervus*. So far as *Madoqua* is concerned this generalisation would seem to be true of the Cavicornia as well as of the other Ruminants. The brain of the Sheep has been so often described and figured† that it may be well regarded as a convenient basis of comparison for other hollow-horned Ruminants. There are in *Madoqua*, as in *Ovis*, three lateral fissures of which I identify the middle one and the longest as the lateral, the other two being ecto- and ento-lateral respectively. The lateral bends outwards anteriorly, but does not end in any other fissure.

Text-fig. 16.

Brain of *Madoqua phillipsi*, dorsal view. Natural size.

- a. Coronal sulcus. c. Inner branch of the same. d. Suprasylvian sulcus.
e. Lateral sulcus. f. Entolateral sulcus. g. Splenial sulcus.

The *suprasylvian* fissure is the same on the two sides of the body and consists of precisely the same elements in the Sheep, excepting that I did not find the fissure lettered by Holl‡ "rdss" and represented in the drawing given by Elliot Smith not far behind the Sylvian fissure, but not lettered. The suprasylvian fissure, however, bifurcates posteriorly in a V-shaped fashion as indicated by Holl in *Ovis*; but in *Madoqua* the two limbs are longer, the downwards directed limb running parallel with the sulcus obliquus. The anteriorly situated "inferior" branch of the suprasylvian joins the sulcus coronalis.

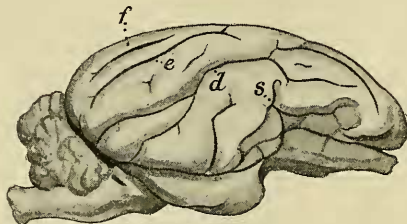
* *Ibid.* p. 326.

† Most recently by Elliot Smith (*loc. cit.* p. 340, figs. 194, 195, 196) and Holl, *Arch. f. Anat.* 1900, pl. xviii. figs. 7, 8, 9.

‡ *Loc. cit.* pl. xviii. fig. 7.

The *Sylvian* fissure in the usual Artiodactyle fashion starts from the edge of the depressed gyrus arcuatus. On one side of the body it is short and runs in a straight course dorsally, being just hooked over anteriorly at the summit. On the other side it is shorter still. There is nothing particular to say of the anterior and posterior ectosylvians.

Text-fig. 17.

Brain of *Madoqua phillipsi*, lateral view. Natural size.

s. Sylvian fissure. Other letters as in text-fig. 16.

The *coronal* sulcus, whose course on either side is straight and parallel with the median sulcus, sends a branch inwards at its posterior end as in other Artiodactyles. This branch, however, does not reach the middle line of the brain on either side. In front of this the gyrus lying between the median sulcus of the hemispheres and the coronal sulcus is indented by the emergence of the splenial sulcus, this indentation being, as I presume, the equivalent of the *crucial* sulcus in other Artiodactyles such as *Ovis**.

(6) *The Brain of Babyrussa alfurus.*

Although the brain of this Suid has been already described by Vrolik †, the description and figures were published a great many years ago and, moreover, do not agree in every detail with the specimens which I have myself had the opportunity of studying. I have examined carefully the brains of two examples of *Babyrussa alfurus* which have died in the Society's Gardens during the last four years ‡, one of which has been drawn for me by Mr. W. S. Berridge, F.Z.S. and is represented in the accompanying text-figure (text-fig. 18, p. 194). The animal was a female. The length of the hemispheres in a straight line is 82 mm., the greatest diameter of the brain 62 mm. I have compared this brain with

* Elliot Smith, *loc. cit.* fig. 195, p. 340.

† Vrolik in N. Verhand. Nederl. Inst. Amsterdam, vol. x. 1844, p. 207. The paper is written in French. The brain is figured in dorsal and ventral views and in section.

‡ The first died June 29th, 1905, the second Jan. 6th, 1908.

specimens of *Sus cristatus* and *Dicotyles tajaçu*, of both of which brains exist in the collection at the Prosectorium.

The coronal sulci are much more obliquely set than in either *Sus* or *Dicotyles*, especially more so than in *Dicotyles*, where the furrows in question, save just where they dip into the middle line, are straight and parallel with the long axis of the brain.

The brain of *Babyrussa* in fact agrees in this particular with that of *Phacochoerus ethiopicus* figured by Elliot Smith*. Not so, however, in their proportionate length; for while in *Phacochoerus*—judging from the figure already referred to—the coronal suture of each side is very nearly half the length of the brain, the length of each of these sulci in *Babyrussa* is 37 mm., measured from the anterior end of the brain to the point where they meet in the middle line of the brain; the rest of the brain measures about 55 mm. These measurements are taken along the curvature of the brain, and are therefore in excess of that just given of the length of the hemispheres.

In *Dicotyles tajaçu* the proportions are reversed, the anterior part of the brain to the posterior end of the coronal sulci is actually longer than the rest of the hemispheres. In *Sus*, however, the proportions would appear to be very much as in *Babyrussa*, and probably by making allowances for the curvature not measurable in the figure quoted, *Phacochoerus* is not very different. Elliot Smith agrees with Garrod† in regarding as distinctive of the Pig tribe the blending of the coronal and intercalary (or splenial) sulci as compared with other Artiodactyles.

The intercalary or splenial sulcus in *Babyrussa* (which obviously suggests—if it be not comparable to—the calloso-marginal of Apes) is continuous with the genual sulcus in front, as in *Sus* and *Dicotyles*. It is also continuous with the coronal, bifurcating, in fact, as it were anteriorly to form the coronal and genual. In this *Babyrussa* of course agrees with other Pigs, as has been already mentioned. It does not, however, agree with an example of *Dicotyles tajaçu* which I have in my possession. I am not quite able to understand precisely what the late Prof. Garrod meant when he wrote concerning the splenial fissure of *Dicotyles* as follows‡:—"There is one upward branch of the splenial fissure which joins § the fissura coronalis, and is not a continuation of it, as in *Sus*." Dr. Elliot Smith in dealing with the brain of the same species repeats Garrod's word "joined." I find in the only brain which I have examined no communication whatever between "the cingular arc of fused calcarine, intercalary and genual sulci" and the coronal sulcus on either side of the body. A bridging convolution occupies the place where this fissure would otherwise lie. But if the coronal sulcus were continued back to join the

* Cat. Physiol. Series, Roy. Coll. Surgeons, vol. ii. 2nd ed. 1902, p. 316, fig. 182.

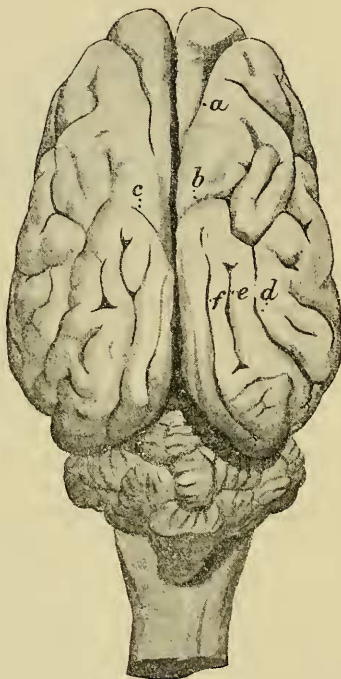
† "On the Brain of Hippopotamus," Trans. Zool. Soc. xi. 1880, p. 13.

‡ Loc. cit. p. 14.

§ The italics are Mr. Garrod's.

splénial (and the gap separating them is but small) there would be no difference in the mode of their connection from that shown in the brain of the *Babyrussa*. There would be a similar appearance of the bifurcation of the splénial that has been referred to.

Text-fig. 18.



Brain of *Babyrussa alfurus*, dorsal view. Three-quarters natural size.

a. Coronal sulcus. *b, c.* Right and left branches of splénial. *d.* Suprasylvian sulcus. *e.* Lateral sulcus. *f.* Entolateral sulcus.

Neither Mr. Garrod nor Dr. Elliot Smith mentions the interesting fact that the convolution lying between the splénial fissure and the corpus callosum (*i. e.* the hippocampal gyrus?) appears on the surface of the brain and is—posteriorly at any rate—not much depressed below the level of adjoining regions of the brain in the Peccary, while it is completely concealed in the *Babyrussa* as in *Sus*, and apparently in *Phacochoerus*. This arrangement is seen in other Ungulates besides *Dicotyles*. In *Babyrussa* the splénial gives rise to another fissure lying behind the oblique furrow which joins it with the superficially running coronal. This is

also well known to occur in *Sus*. But in the specimen of *S. cristatus* which I examined the fissure did not reach the splenial on either side. It may be that this fissure is the real equivalent of what I have described above in *Dicotyles* as the corono-splenial junction. The fissure mentioned by Garrod as the equivalent of the latter does not, however, exist in my specimen.

In any case it is clear that *Babyrussa* agrees with the Old World Pigs, and differs from *Dicotyles*, in the shorter and more obliquely running coronal fissures.

The lateral fissure of *Babyrussa* is less oblique in direction than that of *Sus*, where the two furrows converge greatly anteriorly. There is a well-marked entolateral fissure, and indeed on the right side of one of my two specimens a second entolateral within the first. There is, furthermore, in *Babyrussa* as in *Sus* an ectolateral fissure, which is wanting—as is also the entolateral—in *Phacochoerus** and in *Dicotyles*. In both specimens of the brain of the *Babyrussa* which I possess the ectolateral fissure tends to be rather imperfect, being interrupted along its course by bridging convolutions, and is better developed anteriorly than posteriorly.

Text-fig. 19.



Brain of *Babyrussa alfurus*, lateral view. One-half natural size.

s. Sylvian fissure. d. Suprasylvian.

In *Sus*, on the other hand†, the posterior part of this sulcus is the most clearly marked, as was the case on one side (the right) of one of the *Babyrussa* brains. It is to be noted that this ectolateral sulcus gives off many transverse branchlets in *Babyrussa* as in *Sus*; it is these small transverse furrows only which are visible in *Dicotyles*.

The *suprasylvian* fissure is much like that of *Sus*; and I could see no variations of moment in the two brains of *Babyrussa* nor on the two sides of each brain. The fissure curves round posteriorly towards the ventral surface of the brain, this part corresponding, according to Garrod, with the descending limb of the same fissure in other Artiodactyles. I may remark that *Babyrussa* also agrees with the Wild Swine (*Sus cristatus*) in possessing a small descending limb of the infrasyllian in front of

* Elliot Smith, Cat. Roy. Coll. Surgeons, f. c. fig. 182, p. 316.

Owen, 'The Anatomy of Vertebrates,' vol. iii. 1868, p. 123, fig. 104.

the ascending limb of the same, which, as already described, is connected with the splenial. I do not find this fissure in *Dicotyles*.

It does not seem to me that there can be any doubt as to what is to be regarded as the *Sylvian* fissure in *Babyrussa*. Both specimens agree entirely in the position of the fissure which I thus identify; the only differences were slight ones of length and direction of curvatures. I consider as *Sylvian* the fissure which arises, as shown in the accompanying figure (text-fig. 19, p. 195), from the point where the nonpallial portion of the hemisphere is widest, where the rhinal fissure, that is to say, is most convex towards the pallium. But I am not to be understood to deny that this may be a 'pseudo-sylvian' fissure formed by the meeting of two lips over a true *Sylvian* fissure. Deep down between the opercula an island of Reil is visible, precisely as Dr. Garson has figured* in the Pygmy Hog (*Sus salvania*). The figures of the brain of the *Babyrussa* which are appended to this paper show, in fact, that the characters of the brain are those of other *Suidæ*, and that the divergences from the prevailing pattern in that group are only slight, and not at all in the direction of the New World *Dicotyles*, nor of the remaining allied family, that of the Hippopotamidæ.

Résumé of New Facts.

The following are the principal new facts contained in the foregoing pages and stated as briefly as possible, with references to the pages where the full description will be found.

- (1) The Himalayan Tapir (*Tapirus indicus* or *malayanus*), like the two species of Elephant, has a pleural cavity which is mainly obliterated by the formation of a dense network of strands of connective tissue uniting the two layers of the pleura. (See p. 161.)
- (2) *Hyrax dorsalis* like *H. syriaca* (described by Lonsky) has a third cæcum about an inch long lying between the unpaired and the paired cæca. The orifice of the ileum into the unpaired cæcum has, unlike what is found in *H. syriaca*, a circular valve. There are specific differences between *H. dorsalis* and *H. capensis* in the cæcum. (See p. 166.)
- (3) The azygos vein in *Hyrax capensis* is, as a rule, confined to the right side of the body. An additional vein on the left side is rare. (See p. 162.)
- (4) The sulci of the brain of *Hyrax capensis*† show considerable variation. This is especially noticeable in the *Sylvian* and the pre- and post-*Sylvian*. (See p. 163.)
- (5) *Hyrax* agrees with *Elephas* in possessing a free fold of peritoneum of considerable dimensions attached to each testis

* *Loc. cit.* (on p. 170).

† This is not an entirely new fact, I extend the data of Dr. Elliot Smith.

and floating in the abdominal cavity, the homology of which is doubtful. (See p. 168.)

- (6) The posterior region of the œsophagus in *Sus* (*Porcula salvania*) is covered by a sheet of muscle which arises as a stout muscular slip from the vertebral column from the centrum of the 8th or a closely neighbouring vertebra. This muscle has not been met with in other mammals, but may correspond to minute fascicles which in man bind down the œsophagus to adjacent membranes massed into one large muscle. (See p. 170.)
- (7) The musculature of *Antilocapra americana* shows certain differences from that of other Bovines in the extensors and flexors of the arm and leg. (See p. 175.)
- (8) The colic helicines of *Antilocapra*, *Cephalophus*, *Madoqua*, *Moschus*, *Gazella*, and *Tragulus* are shown to be referable to two categories according to whether the emergent spiral limb of the colon lies to the right or to the left of the entering spiral. Even the two simplest spirals known among Artiodactyles, *i. e.* those of *Madoqua* and *Tragulus*, conform to the one or to the other plan. (See p. 182.)
- (9) Although two species alleged to be of the same genus, viz. *Cephalophus dorsalis* and *C. maxwelli*, show different spirals, it is by no means certain that these two species are rightly referred to one and the same genus. (See p. 181.)
- (10) In no Artiodactyle (whose anatomy is known) is the common form, from which the two types may have diverged, of spiral visible. But the rudimentary spiral of the Galaginæ and Lorisinæ (among Lemurs) is a spiral from which both types of Artiodactyle spiral *might* be derived. (See p. 185.)
- (11) The remarkable spiral of the Musk-Ox, described by Lönnberg, in which the emergent limb is bent once upon itself before leaving the region of the spiral, is closely paralleled in one specimen (out of two) of the Rodent *Dasyprocta punctata*. (See p. 187.)
- (12) The azygos vein of *Madoqua* is like that of *Rhaphicerus* and *Ourebia* in that the left azygos has an anteriorly running branch as well as the chief posteriorly running trunk. These genera are usually placed in the same subfamily—Neotraginæ. (See p. 188.)
- (13) In the brain of *Madoqua*, as in that of other *small* Ruminants, the splenic sulcus is exposed and superficial in position. (See p. 190.)
- (14) The brain of *Babyrussa* is like that of other Old World Suidæ. Its slight divergences are not in the direction of the New World *Dicotyles*. (See p. 192.)
- (15) The brain of *Antilocapra* is remarkable for its squared-off ending anteriorly and for the fact that, as in the Suidæ, the crucial and coronal sulci are confluent. (See p. 173.)